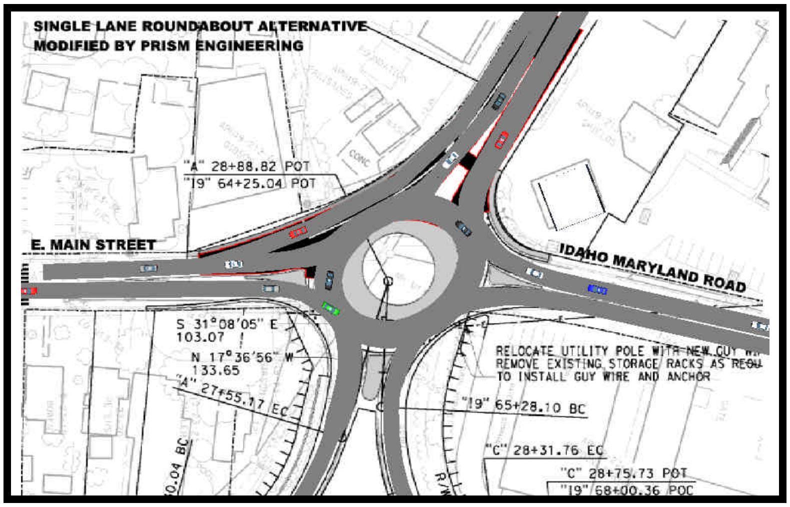
PRISM ENGINEERING

FINAL REPORT

ROUNDABOUT ANALYSIS
At
IDAHO MARYLAND / E. MAIN INTERSECTION



using VISSIM MICROSIMULATION MODEL

Prepared for the
NEVADA COUNTY TRANSPORTATION COMMISSION

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EXECUTIVE SUMMARY

The modern roundabout depicted in Figure 1 of this report will operate acceptably through the Year 2012, and will provide LOS C or better conditions service during the pm peak hour (an improvement over the LOS F condition that exists today).

The roundabout was analyzed in detail using the VISSIM software. The results of the analysis show that the roundabout will also provide more moderate traffic flows from the intersection of Idaho Maryland Road / East Main Street to the SR 20/49 onramp. The measured field data at the current intersection had as many as 148 vehicles enter the ramp in the peak five minute period, whereas the roundabout analysis showed only 79 vehicles in its peak five minute period. Figure 3 compares these flow rates with a line chart.

The roundabout has the following benefits:

- will mitigate levels of service for the intersection.
- will slow platoon rates onto the onramp.
- will provide slower traffic speeds than with a signal.
- will lengthen the time that the freeway weave can operate acceptably.

ANALYSIS RESULTS

The Year 2012 was selected as the analysis year to coincide with five years of additional growth after opening day of the roundabout (assumed 2006/2007). Year 2012 turning movement volumes for the intersection of Idaho Maryland Road and East Main Street at the SR 20/49 WB Ramps, were obtained from Caltrans[1]. These volumes are summarized in Table 1 below.

Table 1
Year 2012 Turning Movement Projections for Idaho Maryland Road and East Main Street PM Peak Hour Volumes

SBR	SBT	SBL	WBR	WBT	WBL	NBR	NBT	NBL	EBR	EBT	EBL
362	371	79	218	306	353	23	65	107	51	195	311

Source: PRISM Engineering and Caltrans

[1] Used previously for analysis of roundabout in Grass Valley Corridor Improvement Project studies.

Existing Intersection Geometry Conditions for Year 2012

The existing four-way stop controlled intersection meters traffic through the intersection, one car at a time, including onto the SR 20/49 freeway onramp. There is an approximately 300 foot weave section on the SR 20/49 mainline freeway where the Idaho Maryland Onramp and Bennett Street Offramp converge. This weave section is nearing an unacceptable LOS E condition, and Caltrans has expressed a concern that the type of mitigated traffic control installed at the Idaho Maryland / East Main Street intersection in the future not aggravate the weave section by increasing platoon traffic.

PRISM Engineering previously conducted a detailed license plate survey during the pm peak hour time period[2]. One of the purposes of that work effort was to determine the flow rate of traffic from the Idaho Maryland Intersection to the freeway on-ramp and to compare that with the expected flow rate from a roundabout.

The license plate survey determined existing traffic patterns between the Idaho Maryland, Auburn Street and Empire Street ramps. License plate data was collected for each vehicle at the following consecutive freeway ramps:

1. Idaho Maryland Road SR 20/49 WB onramp
2. Auburn Street SR 20/49 WB onramp
3. Empire Street SR 20/49 WB offramp

The last three numbers of each license plate were written for each vehicle entering the respective ramp. The data was organized into five-minute intervals during the peak hour time period (4:15 to 5:15 pm). This data was then transcribed into a computer spreadsheet, and saved as a text file for post-processing in a computer program written by PRISM Engineering that found license plate matches between the three ramps. The summary of origin destination data is given in Table 2, and relates to traffic patterns during the pm peak hour time period.

In the survey, 792 vehicles got onto the Idaho Maryland freeway onramp during the pm peak hour. 113 vehicles did not get directly on the freeway, but went down the Bennett Street offramp. 69 of these were "tracked" via license plate survey to determine that they went to the Auburn Street on-ramp and on to Empire Street. Table 2 shows that 138 vehicles entered the Auburn Street on-ramp, and continued on to the Empire Street off-ramp. Row two of the table indicates that 160 of vehicles that entered the freeway at the Idaho Maryland on-ramp got off at the Empire Street off-ramp. The

[2] <u>OPERATIONS TRAFFIC STUDY FOR SR 20/49 FRONTAGE ROAD</u>, February 12, 2004

total traffic from the Idaho Maryland onramp that got off at Empire Street was 229 vehicles (160+69), or about 29% of the total onramp traffic.

Table 2
Origin Destination Data Summary

Origin Location	Destination 1 Bennett Street Off-ramp (vph)	Destination 2 Auburn Street On-ramp (vph)	Destination 3 Empire Street Off-ramp (vph)
Idaho Maryland On-ramp via Frontage Road	113	69	69
Idaho Maryland On-ramp via SR 20/49 Freeway	N/A	N/A	160
Auburn Street On-ramp at Colfax Triangle	N/A	N/A	138

Source: PRISM Engineering

Table 3 reports the actual vehicle count, by five minute interval during the pm peak hour, of traffic that is getting onto the SR 20/49 Onramp from the Idaho Maryland / East Main Street intersection.

Table 3
Five Minute Interval Traffic Count
SR 20/49 WB Onramp, (VPH)

4:15 pm	4:20 pm	4:25 pm	4:30 pm	4:35 pm	4:40 pm	4:45 pm	4:50 pm	4:55 pm	5:00 pm	5:05 pm	5:10 pm	Total
60	148	47	58	69	42	70	49	64	54	55	76	792

Source: PRISM Engineering

MICRO-SIMULATION MODEL DEVELOPMENT

For this report, Caltrans District 3 requested that the VISSIM traffic simulation model software be used to analyze the roundabout design for the intersection of Idaho Maryland and East Main Street. This software allows for more precise lane widths, limit line location, accurate curved links, variable traffic control devices, specific routing of vehicles along a certain path, etc. Because of this, the model can produce slightly more accurate results of delay and assignment than is possible with the SimTraffic software. The current design concept for the study intersection is shown in Figure 1.

PRISM Engineering developed a VISSIM microsimulation traffic model to match the dimensions and scale of the design concept shown in Figure 1. This was accomplished by importing the bitmap of the drawing into VISSIM, and placing link segments, curves, limit lines, and traffic control at the precise locations above the drawing. The exact shape and length of each approach, along with lane widths and internal roundabout shape were incorporated into the VISSIM model.

The original source of this design was a single lane roundabout design prepared recently under the direction of the NCTC, but the design shown in Figure 1 reflects a design modification (shown in black for emphasis) to accommodate a bypass lane for the southbound right (SBR) turn pocket traffic. By allowing the SBR traffic to bypass the roundabout, it is possible to achieve satisfactory traffic flows and levels of service through the Year 2012.

The separation of the SBR lane from the internal roundabout traffic is achieved through the installation of a raised concrete median. Traffic in the SBR lane is under YIELD traffic control for the merge into the East Main Street westbound leg leaving the roundabout towards downtown.

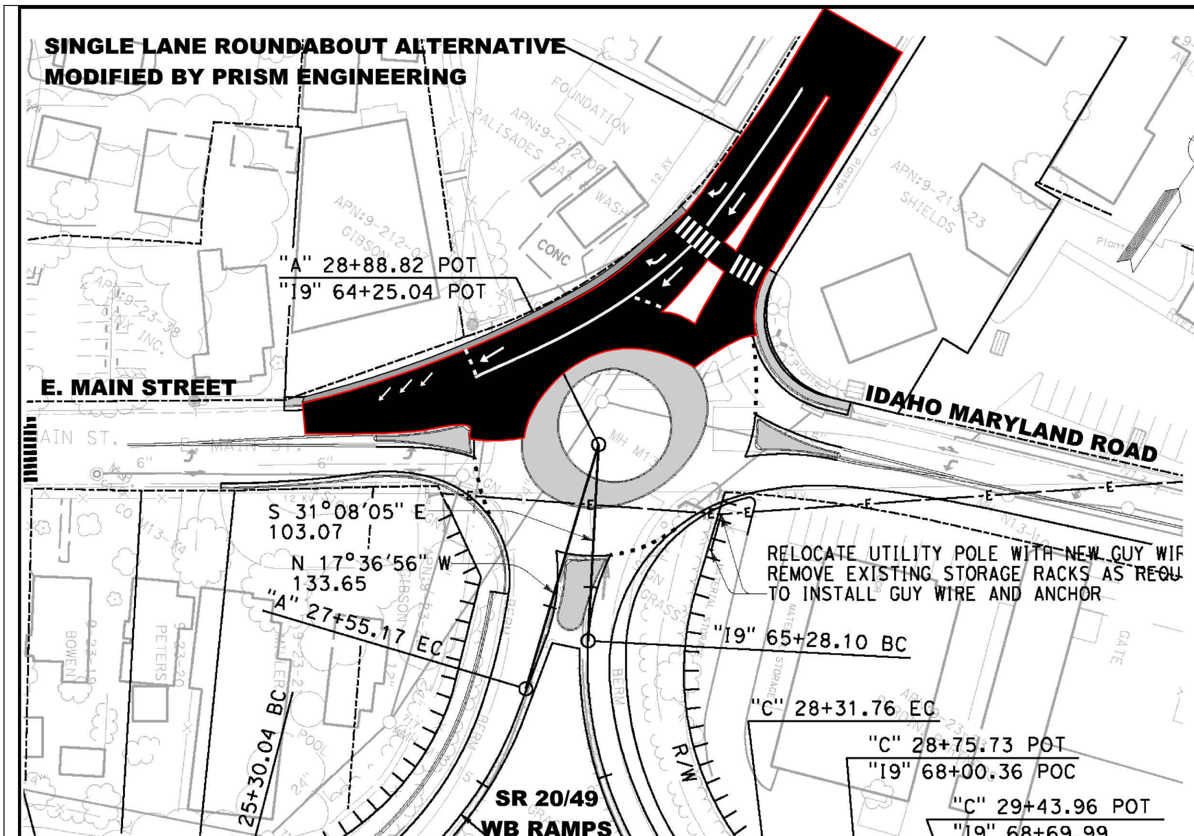

Figure 1 Current Roundabout Design Concept

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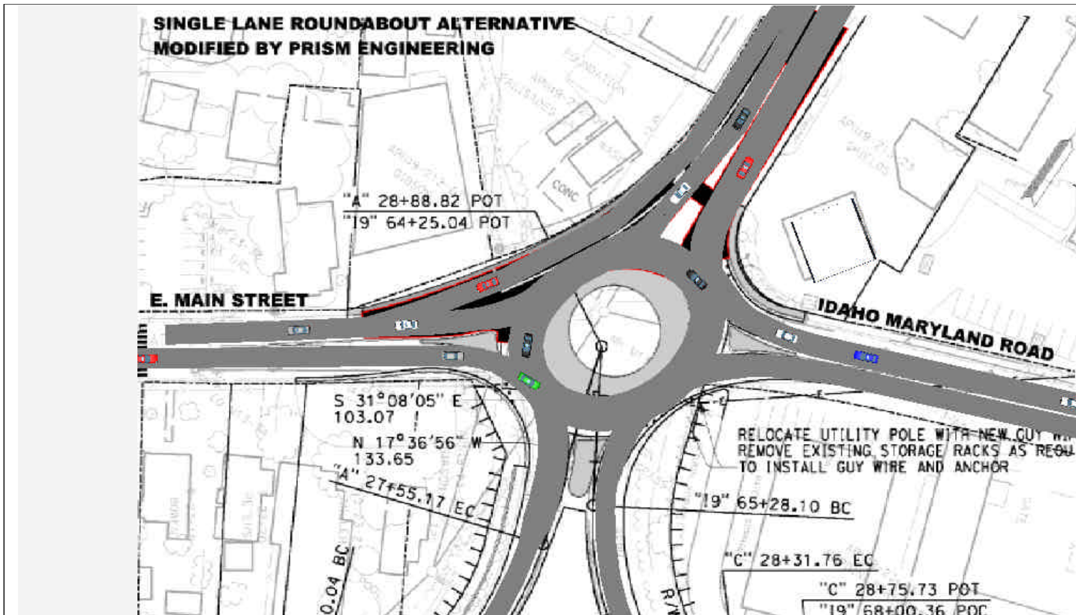

Figure 2 VISSIM Roundabout Implementation

Figure 2 shows the VISSIM implementation of the roundabout design concept shown in Figure 1. The VISSIM model for the Year 2012 traffic projections yielded the following results: LOS C conditions, overall (see discussion below).

Onramp Traffic Flows After Roundabout

Table 4 shows the predicted VISSIM results for the Idaho Maryland Onramp traffic flows.

Table 4
Five Minute Interval Traffic Count
SR 20/49 WB Onramp, (VPH)

4:15 pm	4:20 pm	4:25 pm	4:30 pm	4:35 pm	4:40 pm	4:45 pm	4:50 pm	4:55 pm	5:00 pm	5:05 pm	5:10 pm	Total
49	71	65	79	75	75	57	65	65	57	71	63	792

Source: PRISM Engineering

Figure 3 shows how the five minute interval traffic flow totals for the roundabout condition differ from the existing four-way stop control condition.

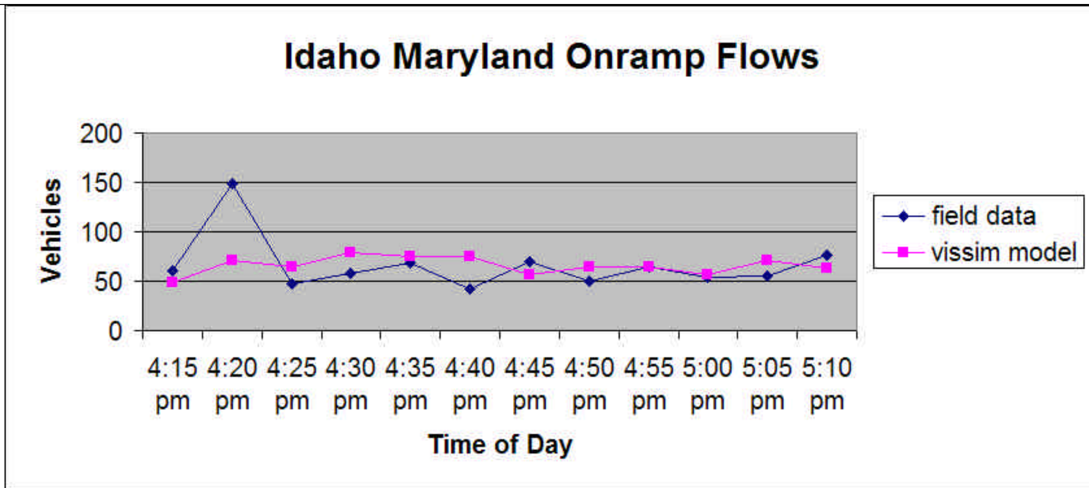

Figure 3 Comparison of Onramp Traffic Flows

It can be seen from the chart in Figure 3 that the existing intersection geometry condition traffic flows (shown in blue) as measured in the field, had a very high peak during the second five minute interval (at 4:20 pm). The roundabout output to the onramp (shown in magenta) during the same time period for the Year 2012 volumes did not experience any high spike in traffic flow, but maintained a more even flow rate overall. Caltrans had expressed concern over the previously unknown traffic flow output from the roundabout onto the onramp. The concern was based in the possibility that the roundabout (operating more efficiently than the four-way stop control at reducing queues on Idaho Maryland Road and East Main Street), would send traffic more rapidly onto the freeway onramp, and thus potentially aggravate the mainline freeway weave. The VISSIM analysis shows that this will not be the case. The field data shows that the existing four-way stop sign control actually has the potential to send larger volumes of traffic onto the onramp during a short period of time. The highest 15 minute interval for existing conditions was 255 vehicles. The roundabout alternative's highest 15 minute interval was only 229 vehicles.

The largest platoon observed in the VISSIM model for traffic getting onto the freeway onramp at this intersection was four vehicles, with most platoons being only two to three vehicles evenly spaced. Although the current design shown in Figure 2 will not operate acceptably with future Year 2027 volumes, it *will* function satisfactorily through the Year 2012, or beyond the time that the Dorsey Drive interchange is expected to be built (which is expected to further relieve this intersection).

Table 5 reports the delay by intersection approach for the VISSIM model with Year 2012 traffic conditions.

Table 5
Five Minute Interval Delay Summary
From VISSIM Roundabout Model

	SR 20/49 Offramp		Idaho Maryland WB		E. Main St. SB		Bypass Lane		E. Main St. EB	
Time	**Delay**	**#Veh**	**Delay**	**#Veh**	**Delay**	**#Veh**	**Delay**	**#Veh**	**Delay**	**#Veh**
4:15 pm	2.6	14	4.8	51	6.6	38	3.4	22	9.3	38
4:20 pm	5.1	15	9	60	4.7	42	5.9	35	26.4	48
4:25 pm	8.3	22	8.8	49	10.5	40	4.5	31	32.8	52
4:30 pm	4.2	17	4.2	63	38.3	42	5.1	18	32.8	37
4:35 pm	6	15	5.5	59	21.5	36	3.9	34	46.7	54
4:40 pm	5.2	15	6	57	11.4	43	3.2	26	39.9	47
4:45 pm	5.3	18	11.2	60	7.8	28	2.8	34	11.7	46
4:50 pm	4.8	18	15.4	62	8.7	37	5	34	18.2	39
4:55 pm	3.4	14	4.3	46	5.9	37	5.6	39	10.7	48
5:00 pm	5.7	21	6.5	50	6.4	34	3.4	27	7.5	43
5:05 pm	5	13	7.3	54	6.1	34	3.9	31	12.1	46
5:10 pm	6.9	12	7.6	53	6.7	33	4.5	30	25.4	61
Total	**5.3**	**194**	**7.7**	**664**	**11.6**	**444**	**4.3**	**361**	**23.5**	**559**

Source: PRISM Engineering

As can be seen from Table 5, the average delays shown in the bottom "Total" row have a range from 4.3 seconds on the Bypass Lane approach to a high of 23.5 seconds average delay for the E. Main Street EB Approach. These hourly averages are within the LOS C range. It should be noted that there were some "spikes" in delay reported at some locations, with a five minute average delay higher than these ranges. In these cases, the LOS for the five minute period would be worse than the hourly average. For example, the E. Main Street SB approach would experience a five-minute average delay of 38.3 seconds at 4:30 pm, but reduce to 21.5 seconds in the next five minute analysis interval. Typically the delay results are reported only for one hour and/or 15 minute intervals. Table 6 reports the level of service ranking criteria for unsignalized intersections.

Table 6
Delay Level of Service Criteria

LOS	**Unsignalized Intersection**
A	1-10 seconds
B	11-15 seconds
C	16-25 seconds
D	26-35 seconds
E	36-50 seconds
F	51+ seconds

Source: PRISM Engineering, Synchro Pro, and HCM

The roundabout is expected to operate at LOS C or better conditions based on the criteria shown in Table 6, and the average delay for the E. Main Street EB approach being 23.5 seconds (LOS C range).

Table 7 shows the average and maximum queue lengths expected from the same scenario in five minute intervals. Although some maximum queues for five minute intervals in Table 7 are large, the average and maximum queues for the hour shown on the bottom row are well within the existing constraints of the roadway system.

The proper way to interpret this information is to consider that the maximum queue lasts for a short time during the five minute interval. For example, at 4:35 pm the E. Main Street EB approach will have a maximum queue length of 453 feet, but the average is only 179 feet for the five minute interval. This means that there are times during the five minute interval where the queue length is much less than 179 feet (possibly cleared) so as to make it possible for the average to be only 179 feet.

Table 7
Five Minute Queue Length Summary
From VISSIM Roundabout Model

	SR 20/49 Offramp		Idaho Maryland WB		E. Main St. SB		Bypass Lane		E. Main St. EB	
	Queue in Feet		Queue in Feet		Queue in Feet		Queue in Feet		Queue in Feet	
Time	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
4:15 pm	1	46	2	42	13	157	0	0	17	176
4:20 pm	5	69	2	59	17	158	1	45	96	290
4:25 pm	12	110	32	281	22	175	2	55	115	385
4:30 pm	7	73	0	19	162	337	1	41	133	422
4:35 pm	5	66	3	47	21	150	0	0	179	453
4:40 pm	1	49	17	218	4	46	0	0	62	326
4:45 pm	5	75	10	226	5	63	0	0	10	78
4:50 pm	3	68	27	361	2	53	0	32	19	119
4:55 pm	4	68	3	94	8	82	0	0	14	148
5:00 pm	19	125	24	297	8	87	0	17	10	105
5:05 pm	3	50	4	70	9	83	1	41	37	154
5:10 pm	5	48	47	368	13	89	1	37	85	391
Total	**6**	**71**	**14**	**174**	**24**	**123**	**1**	**22**	**65**	**254**

Source: PRISM Engineering